NOAA SCIENTIFIC PUBLICATIONS REPORT
JULY 3, 2017

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Economic valuation of shoreline protection within the Jacques Cousteau National Estuarine Research Reserve
NOAA Technical Memorandum Series (n/a)

Potential impact of climate change on the Intra-Americas Sea: Part 2. Implications for Atlantic bluefin tuna and skipjack tuna adult and larval habitats
Journal of Marine Systems (2.476)

Managing consequences of climate-driven species redistribution requires integration of ecology, conservation and social science
Biological Reviews (11.615)

Projecting the effects of climate change on *Calanus finmarchicus* distribution within the U.S. Northeast Continental Shelf
Scientific Reports (4.259)

Variability and trends in surface seawater pCO2 and CO2 flux in the Pacific Ocean
Geophysical Research Letters (4.456)

Ecophysiological examination of the Lake Erie *Microcystis* bloom in 2014: Linkages between biology and the water supply shutdown of Toledo, OH
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PLoS ONE (2.806)

More reliable coastal SST forecasts from the North American Multimodel Ensemble
Climate Dynamics (4.619)

On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability
Climate Dynamics (4.619)

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Augmenting anti-cancer natural products with a small molecule adjuvant
Marine Drugs (3.512)

NWS PUBLICATIONS

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Using choice models to inform large marine protected area design
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Genetic connectivity of dungeness crab (*Cancer magister*) across oceanographic regimes
Journal of Shellfish Research (0.791)

Functional analysis of All Salmonid Genomes: An international initiative supporting future salmonid research, conservation, and aquaculture
BMC Genomics (3.867)

Social interactions among grazing reef fish drive material flux in a coral reef ecosystem
Proceedings of the National Academy of Science of the United States of America (9.661)

Rapid seafood species identification using chip-based capillary electrophoresis and protein pattern matching
Journal of AOAC International (1.05)

Discovery and characterization of single nucleotide polymorphisms in two anadromous alosine fishes of conservation concern
Ecology and Evolution (2.537)

Primnoidae (Octocorallia: Calcaxonia) from the Emperor Seamounts, with notes on *Callogorgia elegans* (Gray, 1870)
Pacific Science (0.924)

Habitat science is an essential element of ecosystem-based fisheries management
Fisheries (3.00)

The impact of the ocean observing system on estimates of the California Current circulation spanning three decades
Progress in Oceanography (3.391)

A global biogeographic classification of the mesopelagic zone
Deep-Sea Research Part I (2.684)

Molecular population genetics of the northern elephant seal *Mirounga angustirostris*
Journal of Heredity (2.075)

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Marine Chemistry(2.457)

Recent increase of surface particulate matter concentrations in the Seoul Metropolitan Area, Korea
Scientific Reports (4.259)

A long-term WRF meteorological archive for dispersion simulations: Application to controlled tracer experiments
Journal of Applied Meteorology and Climatology (2.463)

Lake bacterial assemblage composition is sensitive to biological disturbance caused by an invasive filter feeder
mSphere (n/a)

Arctic regional methane fluxes by ecotope as derived using eddy covariance from a low-flying aircraft
Atmospheric Chemistry and Physics (5.11)

Drivers and environmental responses to the changing annual snow cycle of northern Alaska
Bulletin of the American Meteorological Society (7.929)

Radium-228 as a tracer of dissolved trace element inputs from the Peruvian continental margin
Marine Chemistry (2.457)

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NOS

White paper on Gulf of Mexico mercury fate and transport: Applying scientific research to reduce the risk from mercury in Gulf of Mexico seafood
NCCOS Technical Memorandum

HIGHLIGHTED ARTICLES

Economic valuation of shoreline protection within the Jacques Cousteau National Estuarine Research Reserve
NOAA Technical Memorandum Series (n/a)
J. Loerzel , M. Gorstein, S. Gonyo , C. Fleming , A. Orthmeyer (NOS/NCCOS), and A. Rezaie

- It was found that the marsh in the Jacques Cousteau National Estuarine Research Reserve and surrounding study area is worth ~$8.34 million during a Hurricane Sandy event; ~$13.08 million in a 50-year storm event; and, ~$9.83 in a 25-year storm event to non-commercial, residential property owners.
- When the three storm events were modeled under future projected marsh cover and sea levels for the year 2050, it was found that the marsh would be worth: ~$32.09 million in a Hurricane Sandy event; ~$19.93 million in a 50-year storm event; and, ~$1.54 million in a 25-year storm event.
- It was also found that participation in open space preserve enabled the communities in the area of interest to save ~$1.42 million on their flood insurance premiums in 2013 ($1.44 million in year 2015 dollars).
- By utilizing community-specific marginal propensity to consume data, it was calculated that the savings attributed to open space preserve led to an extra $1.04 million (year 2015 dollars) in direct expenditures for the area of interest in 2013.
- Through multiplier effects, the $1.04 million in direct expenditures can be expected to lead to a $938,973 output contribution, a $451,500 income contribution, and an employment contribution of 12 full time jobs.

Ecosystem service valuation provides natural resource economists with the ability to place values on natural ecosystems and to assess the true costs and benefits of different management alternatives. A vast array of services are produced by healthy ecosystems, including shoreline protection/stabilization. Shoreline habitats operate as natural infrastructure and can help protect shorelines, human development, and economic activity by reducing the impacts of coastal hazards. In a given storm event, the presence of marsh can attenuate wave height and flooding impacts, and in turn, mitigate property damages. This particular study focuses on the Jacques Cousteau National Estuarine Research Reserve (JC NERR), and utilizes the "damages avoided" method, in which the protectionary benefits of a natural habitat are measured by considering the property damage costs that would

be incurred if the flood control provision (e.g. the flood protection provided by a natural habitat) were not present. Additionally, a second, market-based method was used to quantify the value of open space preservation (OSP) in terms of its effect on flood insurance premiums through the National Flood Insurance Program Community Rating System (NFIP CRS).

Potential impact of climate change on the Intra-Americas Sea: Part 2. Implications for Atlantic bluefin tuna and skipjack tuna adult and larval habitats
Journal of Marine Systems (2.476)
B. A. Muhling (NMFS/SEFSC), Y. Liu (OAR/AOML), S. Lee (OAR/AOML), J. Lamkin (NMFS/SEFSC), M. Roffer, F. Muller-Karger, and **J. Walter (NMFS/SEFSC)**

- This paper examines potential climate change impacts on thermal habitats of skipjack and bluefin tunas in the Gulf of Mexico and Caribbean Sea.
- Results showed marked temperature-induced habitat losses for both adult and larval bluefin tuna, with increased habitat suitability for skipjack tuna as temperatures warmed.
- The work suggests that influences of climate change on highly migratory Atlantic tuna species are likely to be substantial, but strongly species-specific.

Increasing water temperatures due to climate change will likely have significant impacts on distributions and life histories of Atlantic tunas. In this study, the authors combined predictive habitat models with a downscaled climate model to examine potential impacts on adults and larvae of Atlantic bluefin tuna (*Thunnus thynnus*) and skipjack tuna (*Katsuwonus pelamis*) in the Intra-Americas Sea (IAS). An additional downscaled model covering the 20th century was used to compare habitat fluctuations from natural variability to predicted future changes under two climate change scenarios: Representative Concentration Pathway (RCP) 4.5 (medium-low) and RCP 8.5 (high). Results showed marked temperature-induced habitat losses for both adult and larval bluefin tuna on their northern Gulf of Mexico spawning grounds. In contrast, habitat suitability for skipjack tuna increased as temperatures warmed. Model error was highest for the two skipjack tuna models, particularly at higher temperatures. While impacts on fish populations remain uncertain, these changes in habitat suitability will likely alter the spatial and temporal availability of species to fishing fleets, and challenge equilibrium

assumptions of environmental stability, upon which fisheries management benchmarks are based.
Acceptance date: January 30, 2015
Available online:
http://www.sciencedirect.com/science/article/pii/S0924796315000226

Managing consequences of climate-driven species redistribution requires integration of ecology, conservation and social science
Biological Reviews (10.615)
T. C. Bonebrake, C. J. Brown, J. D. Bell, J. L. Blanchard, A. Chauvenet, C. Champion, I. C. Chen, T. D. Clark, R. K. Colwell, F. Danielsen, A. I. Dell, J. M. Donelson, B. Eveng°ard, S. Ferrier, S. Frusher, R. A. Garcia, **R. B. Griffis (NMFS/OST)**, A. J. Hobday, M. A. Jarzyna, E. Lee, J. Lenoir, H. Linnetved, V. Y. Martin, P. C. McCormack, J. McDonald, E. McDonald-Madden, N. Mitchell, T. Mustonen, J. M. Pandolfi, N. Pettorelli, H. Possingham, P. Pulsifer, M. Reynolds, B. R. Scheffers, C. J. B. Sorte, J. M. Strugnell, M.-N. Tuanmu, S. Twiname, A. Verg´es, C. Villanueva, E.Wapstra, T. Wernberg, and G. T. Pecl

- Climate change is driving a pervasive global redistribution of the planet's species.
- Species redistribution poses new risks for society and scientific challenges that require a coordinated and integrated approach for effective understanding and response.
- Ecological, conservation and social research on species redistribution can best be achieved by working across disciplinary boundaries to develop and implement solutions to climate change challenges. The best science will not be useful unless more scientists engage with managers, policy makers and the public to develop responsible and socially acceptable options for the global challenges arising from species redistributions.

Climate change is driving a pervasive global redistribution of the planet's species. Species redistribution poses new questions for the study of ecosystems, conservation science and human societies that require a coordinated and integrated approach. Here we review recent progress, key gaps and strategic directions in this nascent research area, emphasising emerging themes in species redistribution biology, the importance of understanding underlying drivers and the need to anticipate novel outcomes of changes in species ranges. We highlight that species redistribution has manifest implications across multiple temporal and spatial scales

and from genes to ecosystems. Understanding range shifts from ecological, physiological, genetic and biogeographical perspectives is essential for informing changing paradigms in conservation science and for designing conservation strategies that incorporate changing population connectivity and advance adaptation to climate change. Species redistributions present challenges for human well-being, environmental management and sustainable development. By synthesising recent approaches, theories and tools, our review establishes an interdisciplinary foundation for the development of future research on species redistribution. Specifically, we demonstrate how ecological, conservation and social research on species redistribution can best be achieved by working across disciplinary boundaries to develop and implement solutions to climate change challenges. Future studies should therefore integrate existing and complementary scientific frameworks while incorporating social science and human-centred approaches. Finally, we emphasise that the best science will not be useful unless more scientists engage with managers, policy makers and the public to develop responsible and socially acceptable options for the global challenges arising from species redistributions.
Acceptance date: February 1, 2017

Projecting the effects of climate change on Calanus finmarchicus *distribution within the U.S. Northeast Continental Shelf*
Scientific Reports (4.259)
B. D. Grieve, J. A. Hare, V. S. Saba (NMFS/NEFSC)

- By 2081-2100, we project average *Calanus finmarchicus* density will decrease by as much as 50% under a high greenhouse gas emissions scenario.
- These decreases are particularly pronounced in the spring and summer in the Gulf of Maine and Georges Bank.
- When compared to a high-resolution global climate model, the ensemble showed a more uniform change throughout the Northeast U.S. Shelf, while the high-resolution model showed larger decreases in the Northeast Channel, Shelf Break, and Central Gulf of Maine. *C. finmarchicus* is an important link between primary production and higher trophic levels, and the decrease projected here could be detrimental to the North Atlantic Right Whale and a host of important fishery species.

Calanus finmarchicus is vital to pelagic ecosystems in the North Atlantic Ocean. Previous studies suggest the species is vulnerable to the effects of global warming,

particularly on the Northeast U.S. Shelf, which is in the southern portion of its range. In this study, we evaluate an ensemble of six different downscaled climate models and a high-resolution global climate model, and create a generalized additive model (GAM) to examine how future changes in temperature and salinity could affect the distribution and density of *C. finmarchicus*. By 2081-2100, we project average *C. finmarchicus* density will decrease by as much as 50% under a high greenhouse gas emissions scenario. These decreases are particularly pronounced in the spring and summer in the Gulf of Maine and Georges Bank. When compared to a high-resolution global climate model, the ensemble showed a more uniform change throughout the Northeast U.S. Shelf, while the high-resolution model showed larger decreases in the Northeast Channel, Shelf Break, and Central Gulf of Maine. *C. finmarchicus* is an important link between primary production and higher trophic levels, and the decrease projected here could be detrimental to the North Atlantic Right Whale and a host of important fishery species.
Acceptance date: June 12, 2017

Variability and trends in surface seawater pCO2 and CO2 flux in the Pacific Ocean
Geophysical Research Letters (4.456)
A. J. Sutton (OAR/PMEL), **R. Wanninkhof (OAR/AOML)**, **C. L. Sabine**, **R. A. Feely**, **M. F. Cronin (OAR/PMEL)**, and R. A. Weller

- High-resolution moored time series of sea-air CO2 flux reveal seasonal to decadal variability influences detection of anthropogenic trends.
- Natural variability tends to be underestimated by models and climatologies.
- Anomalous 2013-2015 North Pacific warming cause one moored location to be a net CO2 source for the first time in the observational record.

Variability and change in the ocean sink of anthropogenic carbon dioxide (CO2) have implications for future climate and ocean acidification. Measurements of surface seawater CO2 partial pressure (pCO2) and wind speed from moored platforms are used to calculate high-resolution CO2 flux time series. Here we use the moored CO2 fluxes to examine variability and its drivers over a range of time scales at four locations in the Pacific Ocean. There are significant surface seawater pCO2, salinity, and wind speed trends in the North Pacific subtropical gyre, especially during winter and spring, which reduce CO2 uptake over the 10-year record of this study. Starting in late 2013, elevated seawater pCO2 values driven

by warm anomalies cause this region to be a net annual CO2 source for the first time in the observational record, demonstrating how climate forcing can influence the timing of an ocean region shift from CO2 sink to source.
Publication date: May 30, 2017
Available online:http://onlinelibrary.wiley.com/doi/10.1002/2017GL073814/full

Ecophysiological examination of the Lake Erie Microcystis *bloom in 2014: Linkages between biology and the water supply shutdown of Toledo, OH*
Environmental Science & Technology (5.330)
M. M. Steffen , **T. W. Davis (OAR/GLERL),** R. Michael L. McKay, G. S. Bullerjahn, L. E. Krausfeldt, J. M. A. Stough, M. L. Neitzey, N. E. Gilbert, G. L. Boyer, **T. H. Johengen (OAR/OARO), D. C. Gossiaux (OAR/GLERL), A. M. Burtner (OAR/GLERL), D. Palladino (OAR/GLERL), M. D. Rowe (OAR/OARO),** G. J. Dick, K. A. Meyer, S. Levy, B. E. Boone, **R. P. Stumpf (NOA/NCCOS), T. T. Wynne (NOS/NCCOS)**, P. V. Zimba, D. Gutierrez , and S. W. Wilhelm

- This manuscript describes the biology and molecular ecology of the Lake Erie Bloom during the summer of the Toledo water crisis.
- Based on the expression patterns of genes in this proposed cyanobacterial metabolic network, it appears urea is a key nutrient in terms of its ability to shape cell physiology in the natural environment, something that has previously been suggested in culture.
- Initial research efforts have indicated that urea-rich waters may preferentially select for organisms such as *Microcystis*, even when P is abundant.
- Combined with simulation and wind data, our analysis implies that while the introduction of this bloom into the Toledo water intake was site specific, the conditions which led to its occurrence were not particularly unique, other than the evidence for viral lysis.
- Given that lysis is likely a regular process occurring in a bloom, this suggests a strong chance that this event may recur in the future if significant changes in the ecosystem dynamics of western Lake Erie do not happen.

Annual cyanobacterial blooms dominated by *Microcystis* have occurred in western Lake Erie (U.S./Canada) during summer months since 1995. The production of toxins by bloom-forming cyanobacteria can lead to drinking water crises, such as the one experienced by the city of Toledo in August of 2014, when the city was

rendered without drinking water for >2 days. It is important to understand the conditions and environmental cues that were driving this specific bloom to provide a scientific framework for management of future bloom events. To this end, samples were collected and metatranscriptomes generated coincident with the collection of environmental metrics for eight sites located in the western basin of Lake Erie, including a station proximal to the water intake for the city of Toledo. These data were used to generate a basin-wide ecophysiological fingerprint of Lake Erie *Microcystis* populations in August 2014 for comparison to previous bloom communities. Our observations and analyses indicate that, at the time of sample collection, *Microcystis* populations were under dual nitrogen (N) and phosphorus (P) stress, as genes involved in scavenging of these nutrients were being actively transcribed. Targeted analysis of urea transport and hydrolysis suggests a potentially important role for exogenous urea as a nitrogen source during the 2014 event. Finally, simulation data suggest a wind event caused microcystin-rich water from Maumee Bay to be transported east along the southern shoreline past the Toledo water intake. Coupled with a significant cyanophage infection, these results reveal that a combination of biological and environmental factors led to the disruption of the Toledo water supply. This scenario was not atypical of reoccurring Lake Erie blooms and thus may reoccur in the future.
Publication date: May 23, 2017
Available online: https://www.glerl.noaa.gov/pubs/fulltext/2017/20170017.pdf

Climate change as a long-term stressor for the fisheries of the Laurentian Great Lakes of North America
Reviews in Fish Biology and Fisheries (3.575)
P. D. Collingsworth, D. B. Bunnell, M. W. Murray, Y. C. Kao, Z. S. Feiner, R. M. Claramunt, **B. M. Lofgren (OAR/GLERL),** T. O. Höök, S. A. Ludsin

- This is a review of aspects of climate change that impact upon fishes of the Great lakes. Attention is paid to the effects of length and strength of stratification, ice cover, and water levels as physical influences, and thermal habitat, growth rate, prey density, and recruitment, in the context of non-climate stressors such as habitat loss and invasive species.
- This work connects various aspects of NOAA work by including both climate and fishes of the Great Lakes.

The Laurentian Great Lakes of North America provide valuable ecosystem services, including fisheries, to the surrounding population. Given the prevalence

of other anthropogenic stressors that have historically affected the fisheries of the Great Lakes (e.g., eutrophication, invasive species, overfishing), climate change is often viewed as a long-term stressor and, subsequently, may not always be prioritized by managers and researchers. However, climate change has the potential to negatively affect fish and fisheries in the Great Lakes through its influence on habitat. In this paper, we (1) summarize projected changes in climate and fish habitat in the Great Lakes; (2) summarize fish responses to climate change in the Great Lakes; (3) describe key interactions between climate change and other stressors relevant to Great Lakes fish, and (4) summarize how climate change can be incorporated into fisheries management. In general, fish habitat is projected to be characterized by warmer temperatures throughout the water column, less ice cover, longer periods of stratification, and more frequent and widespread periods of bottom hypoxia in productive areas of the Great Lakes. Based solely on thermal habitat, fish populations theoretically could experience prolonged optimal growth environment within a changing climate, however, models that assess physical habitat influences at specific life stages convey a more complex picture. Looking at specific interactions with other stressors, climate change may exacerbate the negative impacts of both eutrophication and invasive species for fish habitat in the Great Lakes. Although expanding monitoring and research to consider climate change interactions with currently studied stressors, may offer managers the best opportunity to keep the valuable Great Lakes fisheries sustainable, this expansion is globally applicable for large lake ecosystem dealing with multiple stressors in the face of continued human-driven changes.
Publication date: May 24, 2017
Available online: https://pubs.er.usgs.gov/publication/70187892

CROSS LINE OFFICE ARTICLES

An analysis of coordinated observations from NOAA's Ronald Brown ship and G-IV aircraft in a landfalling Atmospheric River over the North Pacific during CalWater-2015
Monthly Weather Review (2.758)
P. J. Neiman (OAR/ESRL), N. Gaggini (OAR/ESRL), C. W. Fairall (OAR/ESRL), J. Aikins (OAR/ESRL), **J. R. Spackman (OAR/ESRL)**, L. R. Leung, J. Fan, J. Hardin, **N. R. Nalli (NESDIS/STAR),** and **A. B. White (OAR/ESRL)**

- When atmospheric rivers make landfall along the mountainous West Coast, they can generate beneficial precipitation for water resource management as well as damaging flooding.
- Advancing scientific knowledge about the structure and development of atmospheric rivers prior to landfall is important for improving forecasts, and better understanding their potential benefits and adverse impacts.

To gain a more complete observational understanding of atmospheric rivers (ARs) over the data sparse open ocean, we used a diverse suite of mobile observing platforms deployed on NOAA's *Ronald H. Brown* (RHB) research vessel and G-IV research aircraft during the CalWater-2015 field campaign to describe the structure and evolution of a long-lived AR modulated by six frontal waves over the northeastern Pacific on 20-25 January 2015. Satellite observations and reanalysis diagnostics provided synoptic-scale context, illustrating the warm, moist southwesterly airstream within the quasi-stationary AR situated between an upper-level trough and ridge. The AR remained offshore of the U.S. West Coast but made landfall across British Columbia where heavy precipitation fell. Forty-seven rawinsondes launched from the RHB provided a comprehensive thermodynamic and kinematic depiction of the AR, including uniquely documenting an upward intrusion of strong water-vapor transport in the low-level moist southwesterly flow during the passage of frontal waves 2 through 6. A collocated 1290-MHz wind profiler showed an abrupt frontal transition from southwesterly to northerly flow below 1 km MSL coinciding with the tail-end of AR conditions. Shipborne radar and disdrometer observations in the AR uniquely captured key microphysical characteristics of shallow warm rain, convection, and deep mixed-phase precipitation. Novel observations of sea-surface fluxes in a midlatitude AR documented persistent ocean-surface evaporation and sensible-heat transfer into the ocean. The G-IV aircraft flew directly over the ship, with dropsonde and radar spatial analyses complementing the temporal depictions of the AR from the RHB. The AR characteristics varied, depending on the location of the cross section relative to the frontal waves.

Publication date: June 12, 2017
Available online: http://journals.ametsoc.org/doi/10.1175/MWR-D-17-0055.1

Return of warm conditions in the southeastern Bering Sea: Phytoplankton - Fish
PLoS ONE (2.806)
J. T. Duffy-Anderson (NMFS/AKFSC), P. J. Stabeno (OAR/PMEL), E. C. Siddon (NMFS/AKFSC), A. G. Andrews (NMFS/AKFSC), D. W. Cooper (NMFS/AKFSC), L. B. Eisner (NMFS/AKFSC), E. V. Farley (NMFS/AKFSC), C. E. Harpold (NMFS/AKFSC), R. A. Heintz (NMFS/AKFSC), D. G. Kimmel (NMFS/AKFSC), F. F. Sewall (NMFS/AKFSC), A. H. Spear (NMFS/AKFSC), and E. C. Yasumishii (NMFS/AKFSC)

- Pollock may be able to buffer effects of deleterious warm ecosystem in the short term
- Improved conditions (lower temperatures and high quality prey) in the north may buffer the effects of warming
- This short-term buffering, combined with recent observations (2017) of renewed sea ice presence over southeast Bering Sea shelf and a potential return to average or at least cooler ecosystem conditions, suggests that recent warm year stanza (2014-2016) effects to the pollock population and fishery may be mitigated

In 2014, the Bering Sea shifted back to warmer ocean temperatures (+2℃ above average), bringing concern for the potential for a new warm stanza and broad biological and ecological cascading effects. In 2015 and 2016 dedicated surveys were executed to study the progression of ocean heating and ecosystem response. We describe ecosystem response to multiple, consecutive years of ocean warming and offer perspective on the broader impacts. Ecosystem changes observed include reduced spring phytoplankton biomass over the southeast Bering Sea shelf relative to the north, lower abundances of large-bodied crustacean zooplankton taxa, and degraded feeding and body condition of age-0 walleye pollock. This suggests poor ecosystem conditions for young pollock production and the risk of significant decline in the number of pollock available to the pollock fishery in 2-3 years. However, we also noted that high quality prey, large copepods and euphausiids, and lower temperatures in the north may have provided a refuge from poor conditions over the southern shelf, potentially buffering the impact of a sequential-year warm stanza on the Bering Sea pollock population. We offer the hypothesis that juvenile (age-0, age-1) pollock may buffer deleterious warm stanza effects by either utilizing high productivity waters associated with the strong, northerly Cold Pool, as a refuge from the warm, low production areas of the

southern shelf, or by exploiting alternative prey over the southern shelf. We show that in 2015, the ocean waters influenced by spring sea ice (the Cold Pool) supported robust phytoplankton biomass (spring) comprised of centric diatom chains, a crustacean copepod community comprised of large-bodied taxa (spring, summer), and a large aggregation of midwater fishes, potentially young pollock. In this manner, the Cold Pool may have acted as a trophic refuge in that year. The few age-0 pollock occurring over the southeast shelf consumed high numbers of euphausiids which may have provided a high quality alternate prey. In 2016 a retracted Cold Pool precluded significant refuging in the north, though pollock foraging on available euphausiids over the southern shelf may have mitigated the effect of warm waters and reduced large availability of large copepods. This work presents the hypothesis that, in the short term, juvenile pollock can mitigate the drastic impacts of sustained warming. This short-term buffering, combined with recent observations (2017) of renewed sea ice presence over southeast Bering Sea shelf and a potential return to average or at least cooler ecosystem conditions, suggests that recent warm year stanza (2014-2016) effects to the pollock population and fishery may be mitigated.
Publication date: June 28, 2017
Available online:
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0178955

More reliable coastal SST forecasts from the North American Multimodel Ensemble
Climate Dynamics (4.619)
G. M. Hervieux (OAR/ESRL), M. A. Alexander (OAR/ESRL), C. A. Stock (OAR/GFDL), M. G. Jacox (NMFS/SWFSC), K. Pegion, **E. Becker (NWS/CPC),** F. Castruccio, and D. Tommasi

- Analysis of the forecast skill of the North American Mulitmodel Ensemble indicates that current global climate forecast systems with relatively coarse oceanic and atmospheric resolution have skill in forecasting sea surface temperature anomalies in many coastal large marine ecosystem-scale regions, including the California Current System.
- The forecasts based on the full ensemble are generally more skillful than predictions from even the best single model.

The skill of monthly sea surface temperature (SST) anomaly predictions for large marine ecosystems (LMEs) in coastal regions of the United States and Canada is

assessed using simulations from the climate models in the North American Multimodel Ensemble (NMME). The forecasts based on the full ensemble are generally more skillful than predictions from even the best single model. The improvement in skill is particularly noteworthy for probability forecasts that categorize SST anomalies into upper (warm) and lower (cold) terciles. The ensemble provides a better estimate of the full range of forecast values than any individual model, thereby correcting for the systematic over-confidence (under-dispersion) of predictions from an individual model. Probability forecasts, including tercile predictions from the NMME, are used frequently in seasonal forecasts for atmospheric variables and may have many uses in marine resource management.
Publication date: March 30, 2017
Available online: https://link.springer.com/article/10.1007%2Fs00382-017-3652-7

On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability
Climate Dynamics (4.619)
M. G. Jacox (NMFS/SWFSC), M. A. Alexander, **C. A. Stock (OAR/GFDL), and G. Hervieux (OAR/ESRL)**

- A simple persistence forecast for sea surface temperatures in the California Current System provides considerable skill for lead times up to approximately four months, while skill above persistence is mostly confined to forecasts of late winter/spring and derives primarily from predictable evolution of El Nino Southern Oscillation-related variability.
- While climate models have been used to make sea surface temperature forecasts in the Nino region (equatorial Pacific Ocean where El Nino/La Nina develop) for more than a decade, this study is one of the few that explore the prediction skill in coastal regions.
- These findings have direct implications for regional downscaling of seasonal forecasts and for short-term management of living marine resources.

The California Current System (CCS) is a biologically productive Eastern Boundary Upwelling System that experiences considerable environmental variability on seasonal and interannual timescales. Given that this variability drives changes in ecologically and economically important living marine resources, predictive skill for regional oceanographic conditions is highly desirable. Here, we assess the skill of seasonal sea surface temperature (SST) forecasts in the CCS

using output from Global Climate Forecast Systems in the North American Multi-Model Ensemble (NMME), and describe mechanisms that underlie SST predictability. A simple persistence forecast provides considerable skill for lead times up to ~4 months, while skill above persistence is mostly confined to forecasts of late winter/spring and derives primarily from predictable evolution of ENSO-related variability. Specifically, anomalously weak (strong) equatorward winds are skillfully forecast during El Niño (La Niña) events, and drive negative (positive) upwelling anomalies and consequently warm (cold) temperature anomalies. This mechanism prevails during moderate to strong ENSO events, while years of ENSO-neutral conditions are not associated with significant forecast skill in the wind or significant skill above persistence in SST. We find also a strong latitudinal gradient in predictability within the CCS; SST forecast skill is highest off the Washington/Oregon coast and lowest off southern California, consistent with variable wind forcing being the dominant driver of SST predictability. These findings have direct implications for regional downscaling of seasonal forecasts and for short-term management of living marine resources.
Publication date: March 24, 2017
Available online: https://link.springer.com/article/10.1007%2Fs00382-017-3608-y

ADDITIONAL ARTICLES

NOS Publications

Augmenting anti-cancer natural products with a small molecule adjuvant
Marine Drugs (3.512)
P. G. Wahome, K. R. Beauchesne, **A. C. Pedone**, J. Cavanagh, C. Melander, P. Zimba, and **P. D. R. Moeller (NOS/NCCOS)**

- The authors examined the cytotoxicity of four microbial metabolites
- A marine natural product increases the efficiency of both antibiotic activity and cancer treatments, opening up new pharmaceutical avenues to improve human health.
- This work demonstrates the added value of emerging toxin research to the human and environmental health arenas.

Aquatic microbes produce diverse secondary metabolites with interesting biological activities. Cytotoxic metabolites have the potential to become lead compounds or drugs for cancer treatment. Many cytotoxic compounds, however, show undesirable toxicity at higher concentrations. Such undesirable activity may be reduced or eliminated by using lower doses of the cytotoxic compound in

combination with another compound that modulates its activity. Here, the authors have examined the cytotoxicity of four microbial metabolites [ethyl N-(2-phenethyl) carbamate (NP-1), Euglenophycin, Anabaenopeptin, and Glycolipid 652] using three in vitro cell lines [human breast cancer cells (MCF-7), mouse neuroblastoma cells (N2a), and rat pituitary epithelial cells (GH4C1)]. The compounds showed variable cytotoxicity, with Euglenophycin displaying specificity for N2a cells. This study also examined the modulatory power of NP-1 on the cytotoxicity of the other three compounds and found that at a permissible concentration (125 µg/mL), NP-1 sensitized N2a and MCF-7 cells to Euglenophycin and Glycolipid 652 induced cytotoxicity.
Publication date: December 26, 2014
Available online: http://www.mdpi.com/1660-3397/13/1/65

NWS PUBLICATIONS

Evaluation of NCAR's AutoNowCaster for operational application within the National Weather Service
Weather And Forecasting (1.972)
M. B. Ba (NWS/STI), **L. Xin (NWS/STI)**, J. Crockett, and **S. B. Smith (NWS/STI)**

- AutoNowCaster's 60-minute nowcasts of convective likelihood, which delineated where storms are likely to form, have been modified to be run over major city's air traffic management hubs,
- This study establishes that nowcasts produced using a storm-scale grid, are most useful when interpreted as guidance at a spatial scale of 50 km and within a time frame anywhere between 45 and 90 minutes of the issuance times.

NCAR's AutoNowCaster (ANC) was modified to run over a large domain which encompasses Chicago's, New York City's and Atlanta's Air Traffic Management hubs. ANC produces nowcasts of Convective Likelihood (CL), with higher values delineating areas where storms are likely to form and be sustained, and vice-versa. This paper presents the results of verifying ANC's 60-minute nowcasts of CL over the study area using data collected from June 11 to September 30, 2012. To reduce the high sensitivity of statistical scores to small errors in location and timing, spatial and temporal relaxation techniques were explored. The results show that, at a spatial scale of roughly 50 km and with no temporal relaxation, a CL value of 0.6 is an optimum threshold for nowcasting the general areas both where new storms

may initiate and where existing storms will be sustained. Moreover, at that same spatial scale and with temporal relaxation (45 to 90 minutes from the nowcast issuance time), a CL value of 0.7 is a good threshold for nowcasting convective initiation alone.
Acceptance date: June 3, 2017

NMFS PUBLICATIONS

*Unexpected patterns of global population structure in melon-headed whales (*Peponocephala electra*)*
Marine Ecology Progress Series (2.292)
K. K. Martien (NMFS/SWFSC), **B. L. Hancock-Hanser (NMFS/SWFSC)**, R. W. Baird, J. J. Kiszka, J. M. Aschettino, M. Oremus, **M. C. Hill (NMFS/PIFSC)**

- Confirmation that the Hawaiian and Kohala Resident populations represent genetically distinct populations
- Evidence that patterns of genetic structuring may be driven by social structure and foraging ecology

Foraging specialization, environmental barriers, and social structure have driven the development of strong genetic differentiation within many marine species, including most of the large dolphin species commonly referred to as 'blackfish' (subfamily Globicephalinae). We used mitochondrial sequence data (mtDNA) and genotypes from 14 nuclear microsatellite loci (nDNA) to examine patterns of genetic population structure in melon-headed whales (MHWs, *Peponocephala electra*), a poorly known member of the blackfish family for which genetic structuring is unknown. MHWs are globally distributed in tropical and subtropical waters, and have formed resident populations around oceanic islands. They frequently mass strand, suggesting strong social cohesion within groups. Based on these characteristics, we hypothesized that MHWs would exhibit strong regional genetic differentiation, similar to that observed in other members of the Globicephalinae subfamily. Instead we found only moderate differentiation (median mtDNA ΦST = 0.204, median nDNA FST = 0.012) among populations both within and between ocean basins. Our results suggest that populations of MHWs that are resident to oceanic islands maintain a higher level of genetic

connectivity than is seen in most other blackfish. MHWs may be more behaviorally similar to delphinids from the Delphininae subfamily (particularly the spinner dolphin, Stenella longirostris), which are known to form coastal and island-associated resident populations that maintain genetic connectivity either through occasional long-distance dispersal or gene flow with larger pelagic populations. Our results suggest that differences in social organization may drive different patterns of population structure in social odontocetes.
Acceptance date: May 22, 2017
Available online: https://doi.org/10.3354/meps12203 (not yet activated)

Using choice models to inform large marine protected area design
Marine Policy (2.610)
K. Wallmo (NMFS/OST) and **R. Kosaka (NMFS/SWFSC)**

- This study found that the general public were sensitive to attributes such as size and use type (e.g., no-take, multi-use) related marine protected areas (MPAs) off of the U.S. west coast.
- Generally, economic values were highest for no-take MPAs and lowest for multi-use MPAs. However, these positive values were also related to size and resulted in negative values above different size and use-type thresholds. For example, no-take MPAs generated the highest values only up to a size threshold that was smaller than what was found for multi-use MPAs.
- This result suggests that if public values for ecosystem services associated with MPAs are a consideration for MPA planning, a combination of relatively small, no-take MPAs and larger, multi-use MPAs would generate the highest values.

During the last decade a number of Large Marine Protected Areas (LMPAs) – marine protected areas that exceed a minimum size threshold and are often in offshore or open ocean waters – have been designated in an effort to meet marine conservation objectives. Research on the human dimensions of LMPAs is limited, though comprehensive policy analysis requires an understanding of the full range of social, cultural and economic benefits associated with LMPA designation. This paper addresses this need by employing a stated preference choice experiment survey of U.S. west coast households to examine public preferences for different protected area designs sited off the U.S. west coast. Using data from over 3,000 randomly selected households in California, Oregon, and Washington we estimate

choice models and calculate economic values for a suite of LMPAs that vary in size and in the types of restrictions within area boundaries. Results show that the LMPA size yielding the highest value is ~15.6% of the west coast exclusive economic zone. Results also underscore the importance of restriction type, as there are considerably different threshold sizes above which diminishing returns and negative economic values are derived from no-access reserves, no-take, and multiple-use designations. While the value of any specific configuration can be estimated using the model, results offer insight on optimal use designations from a public perspective for small (< 2.5% of west coast Federal waters), medium (2.5% - ~10%) and large (> 10%) LMPAs sited off the U.S. west coast.
Publication date: June 3, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0308597X16307990

*Genetic connectivity of dungeness crab (*Cancer magister*) across oceanographic regimes*
Journal of Shellfish Research (0.791)
K. G. O'Malley, K. Corbett, D. P. Jacobson, T. M. Jackson, **C. Roegner (NMFS/NWFSC)**

- By combining population-based and individual-based approaches, these results demonstrate that connectivity between ocean and fjord-like areas is reduced and may lead to elevated kinship in isolated populations.
- Ten microsatellite loci were used to examine connectivity among Oregon Dungeness crab in the California Current System as well as between Oregon and two British Columbia populations, Alison Sound and Boundary Bay.

Limited approaches exist for studying population connectivity in widely dispersing marine benthic invertebrates. Genetic techniques can provide important insights toward identifying recruitment trajectories. Here, ten microsatellite loci were used to examine connectivity among Oregon Dungeness crab (*Cancer magister*, Dana 1852) in the California Current System (CCS)(N=801) as well as between Oregon and two British Columbia populations, Alison Sound (N=54) and Boundary Bay (N=48). Using population-based methods (F-statistics), evidence for weak genetic differentiation was found among 12 sites in Oregon that did not conform to a pattern of isolation by distance. While individual-based methods (kinship analyses) indicated higher than expected relatedness in two Oregon sites, this

finding did not help interpret the pattern of genetic differentiation observed among sites in the CCS. Extending our analyses to British Columbia, it was determined that genetic diversity within the Boundary Bay population was comparable to that observed for Oregon while genetic diversity within Alison Sound was considerably lower. Furthermore, genetic connectivity between Oregon and British Columbia was reduced as Alison Sound was genetically distinct from all Oregon sites while Boundary Bay was genetically differentiated from several Oregon sites. In accordance, a Bayesian clustering approach provided support for two genetic groups: 1) Oregon and Boundary Bay, and 2) Alison Sound. Kinship analysis revealed a high degree of relatedness within Alison Sound which helps explain the observed pattern of population differentiation. By combining population-based and individual-based approaches, these results demonstrate that connectivity between ocean and fjord-like areas is reduced and may lead to elevated kinship in isolated populations.
Acceptance date: June 9, 2017

Functional Analysis of All Salmonid Genomes: An international initiative supporting future salmonid research, conservation, and aquaculture
BMC Genomics (3.867)
D. J. Macqueen, C. Primmer, R. Houston, B. Nowak, L. Bernatchez, S. Bersath, W. Davidson, C. Gallardo-Escarate, T. Goldammer, Y. Guiguen, P. Iturra, J. Kijas, B. Koop, S. Lien, A. Maass, S. Martin, P. McGinnity, M. Montecino, K. Naish, **K. M. Nichols (NMFS/NWFSC)**, K. Olafsson, S. Omholt, Y. Palti, G. Plastow, C. Rexroad, M. Rise, S. Sandve, P. Schulte, A. Tello, R. Vidal, J. Olav Vik, A. Wargelius, J. Manuel Yanez

- This paper lays the framework for the functional annotation of salmonid genomes, which will be important for studies on genetic diversity and functional aspects of salmonid physiology.

We describe an emerging initiative - the 'Functional Annotation of All Salmonid Genomes' (FAASG), which will leverage the extensive trait diversity that has evolved since a whole genome duplication event in the salmonid ancestor, to develop an integrative understanding of the functional genomic basis of phenotypic variation. The outcomes of FAASG will have diverse applications, ranging from improved understanding of genome evolution, to improving the efficiency and sustainability of aquaculture production, supporting the future of fundamental and applied research in an iconic fish lineage of major societal importance.

Acceptance date: June 12, 2017

Social interactions among grazing reef fish drive material flux in a coral reef ecosystem

Proceedings of the National Academy of Science of the United States of America (9.661)

M. A. Gil and **A. M. Hein (NMFS/SWFSC)**

- This study describes how fish foraging behaviors are highly dynamic and that fish influence one another's foraging, which allows humans to also modify fish foraging behavior through fishing and other perturbations.
- Changes in fish foraging behaviors are likely to affect fish population dynamics.

In human financial and social systems, exchanges of information among individuals cause speculative bubbles, behavioral cascades, and other correlated actions that profoundly influence system-level function. Exchanges of information are also widespread in ecological systems, but their effects on ecosystem-level processes are largely unknown. Herbivory is a critical ecological process in coral reefs, where diverse assemblages of fish maintain reef health by controlling the abundance of algae. Here, we show that social interactions have a major effect on fish grazing rates in a reef ecosystem. We combined a system for observing and manipulating large foraging areas in a coral reef with a class of dynamical decision-making models to reveal that reef fish use information about the density and actions of nearby fish to decide when to feed on algae and when to flee foraging areas. This "behavioral coupling" causes bursts of feeding activity that account for up to 68% of the fish community's consumption of algae. Moreover, correlations in fish behavior induce a feedback, whereby each fish spends less time feeding when fewer fish are present, suggesting that reducing fish stocks may not only reduce total algal consumption but could decrease the amount of algae each remaining fish consumes. Our results demonstrate that social interactions among consumers can have a dominant effect on the flux of energy and materials through ecosystems, and our methodology paves the way for rigorous in situ measurements of the behavioral rules that underlie ecological rates in other natural systems.

Publication date: May 2, 2017
Available online: http://www.pnas.org/content/114/18/4703.abstract

Rapid seafood species identification using chip-based capillary electrophoresis and protein pattern matching

Journal of AOAC International (1.05)

C. C. Walker (OSF/NSIL), C. L. Lassitter (OSF/NSIL), S. N. Lynn (OSF/NSIL), C. B. Ford (OSF/ NSIL), K. R. Rademacher (NMFS/SEFSC), A. D. Ruple (OSF/NSIL) and J. W. Bell (OSF/NSIL)

- The manuscript describes analytical methods developed for simple protein extraction and species-specific protein pattern recognition to rapidly and inexpensively analyze finfish muscle samples and provide species identification for seafood commonly substituted in the US seafood market.
- The analytical method combines simple water extraction of uncooked finfish proteins and off-the-shelf lab equipment to perform chip-based microfluidic electrophoresis for the quantification of high abundance fish muscle proteins, with a novel data analysis method to determine species-specific protein pattern recognition.

Authenticity is crucial to the seafood industry, as substitution and mislabeling have important economic, environmental and food safety consequences. To address this problem, protein profiling and software algorithm techniques were developed to classify fish muscle samples by species. The method employs water-based protein extraction, chip-based microfluidic electrophoresis (Agilent ® 2100 Bioanalyzer) for the analysis of high abundance fish muscle proteins, and a novel data analysis method for species-specific protein pattern recognition. The method's performance in distinguishing commercially important fish from commonly reported substitutions was evaluated using sensitivity, specificity and accuracy determinations with all three performance measures at > 98% for common substitutions. The study demonstrates that uncooked seafood products of commercially important species of catfish, snapper and grouper can be rapidly distinguished from commonly substituted species with a high level of confidence. A tiered testing approach to seafood species verification by sequentially employing a rapid screening method and DNA testing is proposed to more effectively ensure accurate product labeling.

Acceptance date: May 31, 2017

Discovery and characterization of single nucleotide polymorphisms in two anadromous alosine fishes of conservation concern
Ecology and Evolution (2.537)
D. S. Baetscher, D. J. Hasselman, **K. Reid**, E. P. Palkovacs, **J. C. Garza (NMFS/SWFSC)**

- Describes a new set of molecular genetic resources for two herring species of conservation concern.
- These genetic markers will greatly facilitate ongoing conservation and management of river herring including genetic assignment of marine caught individuals to stock of origin.

Freshwater habitat alteration and marine fisheries can affect anadromous fish species, and populations fluctuating in size elicit conservation concern and coordinated management. We describe the development and characterization of two sets of 96 single nucleotide polymorphism (SNP) assays for two species of anadromous alosine fishes, alewife and blueback herring (collectively known as river herring), that are native to the Atlantic coast of North America. We used data from high-throughput DNA sequencing to discover SNPs and then developed molecular genetic assays for genotyping sets of 96 individual loci in each species. The two sets of assays were validated with multiple populations that encompass both the geographic range and the known regional genetic stocks of both species. The SNP panels developed herein accurately resolved the genetic stock structure for alewife and blueback herring that was previously identified using microsatellites and assigned individuals to regional stock of origin with high accuracy. These genetic markers, which generate data that is easily shared and combined, will greatly facilitate ongoing conservation and management of river herring including genetic assignment of marine caught individuals to stock of origin.
Acceptance date: June 9, 2017

*Primnoidae (*Octocorallia: Calcaxonia*) from the Emperor Seamounts, with notes on* Callogorgia elegans *(Gray, 1870)*
Pacific Science (0.924)
S. D. Cairns and **R. P. Stone (NMFS/AKFSC)**

- Provided new information on the zoogeography and species composition of vulnerable marine ecosystems in an important region of international fishing activities in the North Pacific Ocean.

- Provided important information to the U.S./Korea Joint Project and the nation's obligations to U. N. General Assembly Resolution 61/105.

Six primnoid species are reported from depths of 280–480 m from the southern Emperor Seamounts, including two new species (*Callogorgia imperialis* and *Thouarella taylorae*). Only the new species are fully described and illustrated. Also, *Callogorgia elegans*, which has a confused taxonomic history, is discussed and illustrated. Not unexpectedly, the Emperor Seamount primnoids have a strong affinity with the fauna of the Hawaiian Islands, an affinity that is expected to increase as more collecting is done in the region.
Acceptance Date: June 6, 2017

Habitat science is an essential element of ecosystem-based fisheries management
Fisheries (3.00)
A. R. Marshak and **S. K. Brown (NMFS/OST)**

- Since the release of the 2010 Habitat Assessment Improvement Plan (HAIP), habitat assessments supported by NMFS have led to improved stock assessments for several managed species and advancement of the goals of ecosystems-based fisheries management (EBFM).
- Applied understanding of the ecological role of habitat in marine ecosystems through habitat research and assessments can strengthen ecosystems-based fisheries management implementation, and habitat science is now being applied in an ecosystems-based fisheries management context, but knowledge gaps remain in the detailed, systematic characterization of habitats.
- Continued focus on the habitat aspects of ecosystem processes and their associated species will lead to a more complete implementation of an ecosystem approach to management, and they will provide for the most scientifically sound conservation of our managed species, the ecosystems that support them, and the sustainability of our fisheries.

Publication date: June 1, 2017
Available online: http://www.tandfonline.com/eprint/efur2jd6ee2ceUbVIvd4/full

The impact of the ocean observing system on estimates of the California Current circulation spanning three decades
Progress in Oceanography (3.391)
A. Moore, **M. Jacox (NMFS/SWFSC)**, W. Crawford, B. Laughlin, C. Edwards, J. Fiechter

- 30 years of ocean observing system impacts on circulation metrics are quantified.
- The relative value of different observation variables (e.g., temperature, salinity), platforms (e.g. satellite, in situ), and times/locations for understanding California Current System (CCS) dynamics are evaluated.
- Overall satellite observations have the largest impact, but in situ hydrographic observations have the largest impact per observation.

Data assimilation is now used routinely in oceanography on both regional and global scales for computing ocean circulation estimates and for making ocean forecasts. Regional ocean observing systems are also expanding rapidly, and observations from a wide array of different platforms and sensor types are now available. Evaluation of the impact of the observing system on ocean circulation estimates (and forecasts) is therefore of considerable interest to the oceanographic community. In this paper, we quantify the impact of different observing platforms on estimates of the California Current System (CCS) spanning a three decade period (1980-2010). Specifically, we focus attention on several dynamically related aspects of the circulation (coastal upwelling, the transport of the California Current and the California Undercurrent, thermocline depth and eddy kinetic energy) which in many ways describe defining characteristics of the CCS. The circulation estimates were computed using a 4-dimensional variational (4D-Var) data assimilation system, and our analyses also focus on the impact of the different elements of the control vector (i.e. the initial conditions, surface forcing, and open boundary conditions) on the circulation. While the influence of each component of the control vector varies between different metrics of the circulation, the impact of each observing system across metrics is very robust. In addition, the mean amplitude of the circulation increments (i.e. the difference between the analysis and background) remains relatively stable throughout the three decade period despite the addition of new observing platforms whose impact is redistributed according to the relative uncertainty of observations from each platform. We also consider the impact of each observing platform on CCS circulation variability associated with low-frequency climate variability. The low-frequency nature of the

dominant climate modes in this region allows us to track through time the impact of each observation on the circulation, and illustrates how observations from some platforms can influence the circulation up to a decade into the future.
Acceptance date: March 26, 2017
Available online: https://doi.org/10.1016/j.pocean.2017.05.009

A global biogeographic classification of the mesopelagic zone
Deep-Sea Research Part I (2.684)
T. T. Sutton, M. R. Clark, D. C. Dunn, P. N. Halpin, A. D. Rogers, J. Guinotte, **S. J. Bograd (NMFS/SWFSC)**, M. V. Angel, J. A. A. Perez, K. Wishner, R. L. Haedrich, D. J. Lindsay, J. C. Drazen, A. Vereshchaka, U. Piatkowski, T. Morato, K. Błachowiak-Samołyk, B. H. Robison, K. M. Gjerde, A. Pierrot-Bults, P. Bernal, G. Reygondeau, M. Heino

- Provides a robust global mesopelagic biogeography that will inform policy planning and management for conservation and sustainable use of deep-pelagic marine resources.
- Improves understanding of the nature of oceanic boundaries.

We have developed a global biogeographic classification of the mesopelagic zone to reflect the regional scales over which the ocean interior varies in terms of biodiversity and function. An integrated approach was necessary, as global gaps in information and variable sampling methods preclude strictly statistical approaches. A panel combining expertise in oceanography, geospatial mapping, and deep-sea biology convened to collate expert opinion on the distributional patterns of pelagic fauna relative to environmental proxies (temperature, salinity, and dissolved oxygen at mesopelagic depths). An iterative Delphi Method integrating additional biological and physical data was used to classify biogeographic ecoregions and to identify the location of ecoregion boundaries or inter-regions gradients. We define 33 global mesopelagic ecoregions. Of these, 20 are oceanic while 13 are 'distant neritic.' While each is driven by a complex of controlling factors, the putative primary driver of each ecoregion was identified. While work remains to be done to produce a comprehensive and robust mesopelagic biogeography (i.e., reflecting temporal variation), we believe that the classification set forth in this study will prove to be a useful and timely input to policy planning and management for conservation of deep-pelagic marine resources. In particular, it gives an indication of the spatial scale at which faunal communities are expected to be broadly similar in composition, and hence can inform application of ecosystem-based management

approaches, marine spatial planning and the distribution and spacing of networks of representative protected areas.
Publication date: May 22, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0967063717301437

Molecular population genetics of the northern elephant seal Mirounga angustirostris
Journal of Heredity (2.075)
A. Abadía-Cardoso, N. B. Freimer, K. Deiner, **J. C. Garza (NMFS/SWFSC)**

- Provides an estimate of the extent to which northern elephant seals lost genetic diversity as a consequence of the 18th century bottleneck.
- Provides an estimate of genome-wide mutation rate for short repetitive DNA sequences.
- Evaluates population structure in the species.

The northern elephant seal, *Mirounga angustirostris*, was heavily hunted and declared extinct in the 19th century. However, a colony remained on remote Guadalupe Island, Mexico and the species has since repopulated most of its historical distribution. Here, we present a comprehensive evaluation of genetic variation in the species. First, we assess the effect of the demographic bottleneck on microsatellite variability and compare it with that found in other pinnipeds, demonstrating levels of variation similar to that in species that continue to be threatened with extinction. Next, we use sequence data from these markers to demonstrate that some of the limited polymorphism predates the bottleneck. However, most contemporary variation appears to have arisen recently and persisted due to exponential growth. We also describe how we use the range in allele size of microsatellites to estimate ancestral effective population size before the bottleneck, demonstrating a large reduction in effective size. We then employ a classical method for bacteria to estimate the microsatellite mutation rate in the species, deriving an estimate that is extremely similar to that estimated for a similar set of loci in humans, indicating consistency of microsatellite mutation rates in mammals. Finally, we find slight significant structure between some geographically separated colonies, although its biological significance is unclear. This work demonstrates that genetic analysis can be useful for evaluating the population biology of the northern elephant seal, in spite of the bottleneck that

removed most genetic variation from the species.
Acceptance date: May 31, 2017

OAR PUBLICATIONS

Sea surface aragonite saturation state variations and control mechanisms at the Gray's Reef time-series site off Georgia, USA (2006–2007)
Marine Chemistry(2.457)
L. Xue, W. J. Cai, **A. J. Sutton**, **C. L. Sabine (OAR/PMEL)**

- Surface seawater aragonite mineral saturation state (Ω_{arag}) controlling processes were quantitatively identified using a 1-D model.
- River inputs play the most important role in Ω_{arag} seasonal variations.
- Ω_{arag} is essentially determined by carbonate ion concentration even in the coastal ocean.

We report an annual cycle of surface seawater aragonite mineral saturation state (Ω_{arag}) during 2006–2007 at the Gray's Reef time-series site off Georgia, USA, calculated based on three-hourly observations of carbon dioxide partial pressure (pCO_2) and salinity-derived total alkalinity. Ω_{arag} varied between 2.30 and 4.39 with low values (< 3.00) mainly during February–April 2007 and high values (> 3.50) during July–October 2006 and July–September 2007 as well as during two biological production spikes (April–June 2007). We first present a qualitative analysis of the drivers of Ω_{arag} variability based on property regressions with surface temperature, salinity and apparent oxygen utilization, and then quantify the contributions of temperature, air-sea exchange, mixing, and biological processes to monthly Ω_{arag} net changes using a simple 1-D mass budget model. Our analyses suggest that river inputs played the most important role in the seasonal variation of surface Ω_{arag}, in contrast to temperature control on pCO_2. Nevertheless, the primary processes controlling monthly Ω_{arag} net change varied with time of year. Furthermore, river inputs lowered Ω_{arag} by 0.28 and 0.48 in July–August and September–October 2007 relative to the equivalent periods of 2006. This implies that interannual Ω_{arag} variability at this location may be greater than that due to the influence of increased atmospheric CO_2 over the past few decades, making efforts to discern decadal coastal ocean acidification trends particularly challenging. In addition, although sea surface salinity varies substantially in coastal waters, our analysis suggests that similar to the open ocean Ω_{arag} is essentially determined by carbonate ion concentration ($[CO_3^{2-}]$), not calcium ion concentration ($[Ca^{2+}]$) or

the stoichiometric solubility product (K'_{sp}), both varying substantially with salinity. Finally, we show that the difference between total alkalinity (TA) and dissolved inorganic carbon (DIC) is a better proxy for [CO_3^{2-}] and Ω_{arag} compared with the ratio (TA/DIC) and helps to better elucidate processes affecting Ω_{arag} in coastal oceans.
Publication date: June 1, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0304420316301347

Recent increase of surface particulate matter concentrations in the Seoul Metropolitan Area, Korea
Scientific Reports (4.259)
H. C. Kim (OAR/OARO), S. Kim, B. U. Kim, C. S. Jin, S. Hong, R. Park, S. W. Son, C. Bae, M. A. Bae, C. K. Song, **A. Stein (OAR/ARL)**

- This paper demonstrates that the recent increase of particulate matter concentrations in South Korea is not caused by the change of local or Chinese anthropogenic emissions, but by the change of regional ventilation strength.
- Emission regulation efforts in South Korea are still effective in spite of recent increase of particulate matter.
- Weakening of regional ventilation and degraded air quality in East Asia should be further investigated in terms of climate change.

Recent changes of surface particulate matter (PM) concentration in the Seoul Metropolitan Area (SMA), South Korea, are puzzling. The long-term trend of surface PM concentration in the SMA declined in the 2000s, but since 2012 its concentrations have tended to incline, which is coincident with frequent severe hazes in South Korea. This increase puts the Korean government's emission reduction efforts in jeopardy. This study reports that interannual variation of surface PM concentration in South Korea is closely linked with the interannual variations of wind speed. A 12-year (2004-2015) regional air quality simulation was conducted over East Asia (27-km) and over South Korea (9-km) to assess the impact of meteorology under constant anthropogenic emissions. Simulated PM concentrations show a strong negative correlation (i.e. R=-0.86) with regional wind speed, implying that reduced regional ventilation is likely associated with more stagnant conditions that cause severe pollutant episodes in South Korea. We conclude that the current PM concentration trend in South Korea is a combination

of long-term decline by emission control efforts and short-term fluctuation of regional wind speed interannual variability. When the meteorology-driven variations are removed, PM concentrations in South Korea have declined continuously even after 2012.
Acceptance date: June 25, 2017

A long-term WRF meteorological archive for dispersion simulations: Application to controlled tracer experiments
Journal of Applied Meteorology and Climatology (2.463)
F. Ngan and **A. F. Stein (OAR/ARL)**

- The NOAA ARL HYSPLIT model is one of the most extensively used atmospheric transport and dispersion models in the atmospheric sciences community.
- Having a long-term (year 1980 – 2016) archived WRF dataset that is accessible on-line provides additional capabilities with the HYSPLIT model.
- This paper shows that improvements are made to the NOAA HYSPLIT dispersion model when a new Weather Research Forecasting dataset is developed and applied.

We created a long-term archive of meteorological data using the WRF model to provide data compatible with the HYSPLIT dispersion model and to serve as initial and boundary conditions for simulations at a finer resolution. Based on these WRF data generated with a variety of PBL schemes and nudging options, we run the HYSPLIT model to simulate four controlled tracer experiments – CAPTEX, ANATEX, and OKC80, and METREX - covering different time periods with diverse durations including a summer day, several days in the fall, three months during winter, and one full year, respectively. The evaluation of the WRF results utilizing conventional observations showed a similar statistical performance for the different PBL schemes. Given the limited information the meteorological evaluation alone can provide, we used the dispersion evaluation with measurements from multiple tracer experiments to gain further insight into the most appropriate WRF configuration to generate reasonable data for dispersion applications. The dispersion simulations based on WRF data generated equal or slightly better statistical performance than those driven by the NARR dataset. The statistical comparison showed a mixed impact for the dispersion results driven by the non-nudged and nudged WRF data. The main advantage of the WRF data is the availability of hourly meteorological data from 1980 to the present and the

inclusion of additional variables relevant to atmospheric dispersion not available from NARR. This WRF dataset will be accessible online providing additional capabilities for using different meteorological inputs and a variety of options to compute the HYSPLIT mixing parameters.
Publication date: June 12, 2017
Available online: http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-16-0345.1

Lake bacterial assemblage composition is sensitive to biological disturbance caused by an invasive filter feeder
mSphere (n/a)
V. J. Denef, H. J. Carrick, **J. Cavaletto**, E. Chiang, **T. H. Johengen, H. A. Vanderploeg (OAR/GLERL)**

- Human activities are altering freshwater environments, and much has been learned regarding the sensitivity of bacterial assemblages to a variety of these disturbances.
- This study focuses on the impact of invasive dreissenid mussels (IDMs), a globally distributed group of invasive species with large impacts on freshwater phyto- and zooplankton assemblages.
- We show that IDMs have direct effects on lake bacterioplankton abundance, taxonomic composition, and inferred bacterial functional group representation.

One approach to improve forecasts of how global change will affect ecosystem processes is to better understand how anthropogenic disturbances alter bacterial assemblages that drive biogeochemical cycles. Species invasions are important contributors to global change, but their impacts on bacterial community ecology are rarely investigated. Here, we studied direct impacts of invasive dreissenid mussels (IDMs), one of many invasive filter feeders, on freshwater lake bacterioplankton. We demonstrated that direct effects of IDMs reduced bacterial abundance and altered assemblage composition by preferentially removing larger and particle-associated bacteria. While this increased the relative abundances of many free-living bacterial taxa, some were susceptible to filter feeding, in line with efficient removal of phytoplankton cells of <2 μm. This selective removal of particle-associated and larger bacteria by IDMs altered inferred bacterial functional group representation, defined by carbon and energy source utilization. Specifically, we inferred an increased relative abundance of chemoorganoheterotrophs predicted to be capable of rhodopsin-dependent energy generation. In contrast to the few

previous studies that have focused on the longer-term combined direct and indirect effects of IDMs on bacterioplankton, our study showed that IDMs act directly as a biological disturbance to which freshwater bacterial assemblages are sensitive. The negative impacts on particle-associated bacteria, which have been shown to be more active than free-living bacteria, and the inferred shifts in functional group representation raise the possibility that IDMs may directly alter bacterially mediated ecosystem functions.
Publication date: May 2017
Available online: http://msphere.asm.org/content/2/3/e00189-17

Arctic regional methane fluxes by ecotope as derived using eddy covariance from a low-flying aircraft
Atmospheric Chemistry and Physics (5.11)
D. S. Sayres, **R. J. Dobosy** , C. E. Healy, **E. J. Dumas, J. Kochendorfer**, J. Munster, J. Wilkerson, **B. Baker(OAR/ARL/ATDD)**, and J. G. Anderson

- The permafrost region of the arctic contains large stocks of carbon, potentially a major source of greenhouse gas if the arctic continues to warm.
- The type of instrument suite demonstrated in this paper combined with fixed and remote sensors is well suited to quantifying the emissions of methane and other greenhouse gases and their change with time over large, difficult to reach areas in the remote arctic.

The Arctic terrestrial and sub-sea permafrost region contains approximately 30% of the global carbon stock, and therefore understanding Arctic methane emissions and how they might change with a changing climate is important for quantifying the global methane budget and understanding its growth in the atmosphere. Here we present measurements from a new in situ flux observation system designed for use on a small, low-flying aircraft that was deployed over the North Slope of Alaska during August, 2013. The system combines a small methane instrument based on Integrated Cavity Output Spectroscopy (ICOS) with an air turbulence probe to calculate methane fluxes based on eddy covariance. We group surface fluxes by land class using a map based on LandSat Thematic Mapper (TM) data having 30-meter resolution. We find that wet sedge areas dominate the methane fluxes with a mean flux of 2.1 μg · m −2 · s −1 during the first part of August, with methane emissions from the Sagavanirktok River being the second highest at almost 1 μg · m −2 · s −1 . During the second half of August, after soil temperatures had cooled by 7 ◦ C, methane emissions fell to between 0 and 0.5 μg ·

m −2 · s −1 for all areas measured. We compare the aircraft measurements with an eddy covariance flux tower located in a wet sedge area and show that the two measurements agree quantitatively when the footprints of both overlap. However, fluxes from sedge vary at times by a factor of two or more even within a few kilometers of the tower demonstrating the importance of making regional measurements to map out methane emission spatial heterogeneity. Aircraft measurements of surface flux can play an important role in bridging the gap between ground-based measurements and regional measurements from remote sensing instruments and models.
Publication date: September 30, 2016
Available online:
http://www.atmos-chem-phys-discuss.net/acp-2016-862/acp-2016-862.pdf

Drivers and environmental responses to the changing annual snow cycle of northern Alaska
Bulletin of the American Meteorological Society (7.929)
C. J. Cox (OAR/ESRL), **R. S. Stone (OAR/ESRL)**, D. C. Douglas, **D. M. Stanitski (OAR/CPO)**, G. J. Divoky, **G. S. Dutton (OAR/ESRL)**, **C. Sweeney (OAR/ESLR)**, J. C. George and **D. U. Longenecker (OAR/ESRL)**

- Large scale features of atmospheric circulation, namely the strength and position of the Aleutian Low (a semi-permanent, subpolar area of low pressure located in the Gulf of Alaska near the Aleutian Islands), are important in determining the timing of snowmelt during spring in Alaska by facilitating or inhibiting the transport of warm, moist air into the region. This signals the importance of internal climate variability in the timing of snowmelt.
- A number of other environmental metrics were examined for the onset of spring, including the timing of the breeding season for a species of seabird, the Black Guillemot, near Utquaġvik; the timing of peak discharge from the North Slope river system; the date of melt at a nearby lagoon; and the start of the vegetative growing season, all of which were seen to either respond to the timing of snowmelt or be influenced by the same factors that initiated the melt. Similar observations were made for autumn onset of snowpack.

The timing of the seasonal cycle of snow cover in Alaska and the duration of the snow-free season are important to the typical seasonal characteristics of the broader environment, including the hydrology/water resources, wildlife behavior,

and the vegetative growing season and biogeochemical cycles. Understanding the variability in snow cover and quantifying coupled environmental responses to this variability is important for identifying potential vulnerabilities, improving seasonal forecasts, and monitoring the health of the system as whole. In a new study to be published in the Bulletin of the American Meteorological Society, CIRES and NOAA ESRL researchers and collaborators analyzed the long-term record of snow cover and meteorology observed at the coastal site of Utquaġvik (formerly, Barrow), Alaska, in addition to a number of other long-term records of environmental variables in the region. Focusing on the transition seasons, the springtime snow melt period, and the autumn onset of snowpack, the researchers found that, in general, the timing of the spring melt has been happening earlier, and the first snow in autumn has been happening later since the mid-1970s. Therefore, the length of the snow-free season has also increased substantially. In recent years, 2015 and 2016 were the fourth earliest and record earliest spring snowmelt, respectively, in a record that dates back to the beginning of the 20th century. In addition, autumn 2016 was the latest onset of snow; therefore, the length of the snow-free season in 2016 was 45 percent longer than the 1975-2015 average.

Abstract: Linkages between atmospheric, ecological and biogeochemical variables in the changing Arctic are analyzed using long-term measurements near Utqiaġvik (formerly Barrow), Alaska. Two key variables are the date when snow disappears in spring, as determined primarily by atmospheric dynamics, precipitation, air temperature, winter snow accumulation and cloud cover, as well as the date of onset of snowpack in autumn that is additionally influenced by ocean temperature and sea ice extent. In 2015 and 2016 the snow melted early at Utqiaġvik due mainly to anomalous warmth during May of both years attributed to atmospheric circulation patterns, with 2016 having the record earliest snowmelt. These years are discussed in the context of a 115-year snowmelt record at Utqiaġvik with a trend toward earlier melting since the mid-1970s (-2.86 days/decade, 1975-2016). At nearby Cooper Island, where a colony of seabirds, Black Guillemots, have been monitored since 1975, timing of egg laying is correlated with Utqiaġvik snowmelt with 2015 and 2016 being the earliest years in the 42-year record. Ice-out at a nearby freshwater lagoon is also correlated with Utqiaġvik snowmelt. The date when snow begins to accumulate in autumn at Utqiaġvik shows a trend towards later dates (+4.6 days/decade, 1975-2016), with 2016 the latest on record. The impacts of a lengthening snow-free season on regional phenology, soil temperatures, fluxes of gases from the tundra, and relationships to regional sea ice

conditions are discussed. Better understanding of these interactions is needed to predict the annual snow cycles in the region at seasonal to decadal scales, and to anticipate coupled environmental responses..
Publication date: May 30, 2017
Available online: http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-16-0201.1

Radium-228 as a tracer of dissolved trace element inputs from the Peruvian continental margin
Marine Chemistry (2.457)
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- Radium-228 was used to derive trace element fluxes from shelf and slope sediments and the distribution of ^{226}Ra is broadly consistent S. Pacific Ocean with water masses.
- An extended surface ^{228}Ra plume highlights Peru margin sediment inputs S. Pacific and a co-occurring deep ^{228}Ra plume from the slope indicates sediment inputs to deep water.
- Continental margin sediments are a key source of trace elements to the open ocean.

Continental margins play a central role in the composition of seawater by being an important source of trace element essentials to the functioning of the ocean ecosystems. Here, we measured long-lived radium isotopes (^{226}Ra, ^{228}Ra) along a zonal transect at 12°S (US GEOTRACES GP16) in the eastern tropical South Pacific Ocean. We used ^{228}Ra to quantify the trace element and isotope (TEI) fluxes (DMn, DFe, and DCo) delivered from the Peruvian continental i) shelf and ii) slope. First, elevated ^{228}Ra activities were measured in surface water over the entire transect (~ 8500 km), evidence that the continental shelf is an important source of sediment-derived TEIs not only to coastal areas, but to central Pacific Ocean waters. Modeled ^{228}Ra shelf fluxes combined with water column dissolved TEI/^{228}Ra ratios were used to quantify the shelf-ocean input rates (normalized to shelf-area) for DMn (3.3×10^3 μmol m^{-2} y^{-1}), DFe (1.5×10^3 μmol m^{-2} y^{-1}), and DCo (1.0×10^2 μmol m^{-2} y^{-1}). Second, co-occurring plumes of ^{228}Ra, DFe, and DMn extended over 1800 km from the margin at 1000–2500 m depth, indicative of a continental slope sediment TEI input to the intermediate water column. The ^{228}Ra gradient allowed us to derive an effective horizontal eddy diffusion coefficient (K_h)

of 46 m^2 s^{-1}, which in turn permitted the calculation of slope sediment DMn (6.4 µmol m^{-2} y^{-1}) and DFe (5.9×10^2 µmol m^{-2} y^{-1}) fluxes based on their offshore concentration gradients. On the scale of the South Pacific continental margin between 0–20°S, the DMn shelf flux is approximately 2–3 orders of magnitude higher than the slope flux, while the DFe shelf/slope flux is ~ 3:1. Both shelf and slope sediment derived DMn was transported over a significant distance towards the ocean interior, while DFe concentration gradients were steep, consistent with longer water column residence time for DMn as compared to DFe in marine systems. These findings highlight the importance of considering the continental slope-ocean boundary in the oceanic budgets of biologically-important trace elements.
Publication date: May 29, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0304420316302511

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NOS PUBLICATIONS

White paper on Gulf of Mexico mercury fate and transport: Applying scientific research to reduce the risk from mercury in Gulf of Mexico seafood
NCCOS Technical Memorandum
D. Evans, M. Cohen (NOS/NCCOS), C. Hammerschmidt**,** W. Landing, D. Rumbold, J. Simons, and S. Wolfe

- Mitigation approaches will need to recognize the complexity of the mercury pathways, and the need to incorporate the spatial, temporal, and ecological variability of mercury concentrations among water, sediments, and biota and the demographic variability among consumers.
- Mitigation will need to be implemented at the appropriate spatial and temporal scale to achieve the desired results.
- Each of the four approaches (source reduction, consumption advisories, landscape modification, and fisheries management) can be appropriate for a specific situation, which will require an integrated strategy.

Consumption of marine fish is the greatest source of mercury exposure to United States residents. Consumers along the Gulf of Mexico coast are at enhanced risk because of their high levels of seafood consumption and the likelihood that many species of Gulf of Mexico (Gulf) fish have higher levels of mercury than the same species harvested on other coasts. The Authors developed a whitepaper that

broadly outlines our current knowledge of mercury in the Gulf of Mexico. The Authors make recommendations of research needs and approaches that, if undertaken, would provide coastal managers with the ability to better ameliorate the toxicological risks of mercury to residents of the Gulf of Mexico, and help fulfill mandated requirements to improve impaired water bodies which EPA and the states typically engage through the Total Maximum Daily Load (TMDL) process. Recommendations for scientific research to achieve risk reduction goals include: identification of at risk groups; identification and quantification of locales where methylmercury enters the food web and processes leading to mercury biomagnification by seafood species; identification of locales where methylmercury is produced from inorganic mercury in the Gulf of Mexico; quantification of inorganic mercury and methylmercury inputs to the Gulf, its estuaries, and open waters via atmospheric deposition, watershed deliveries, and oceanic deliveries from the Atlantic Ocean; predicting and measuring the relationships between mercury inputs to the Gulf and local, regional, national, and global emission sources; and develop mitigation strategies.
Publication date: January 2015
Available online:
http://www.arl.noaa.gov/documents/reports/NCCOS%20TM-192.pdf